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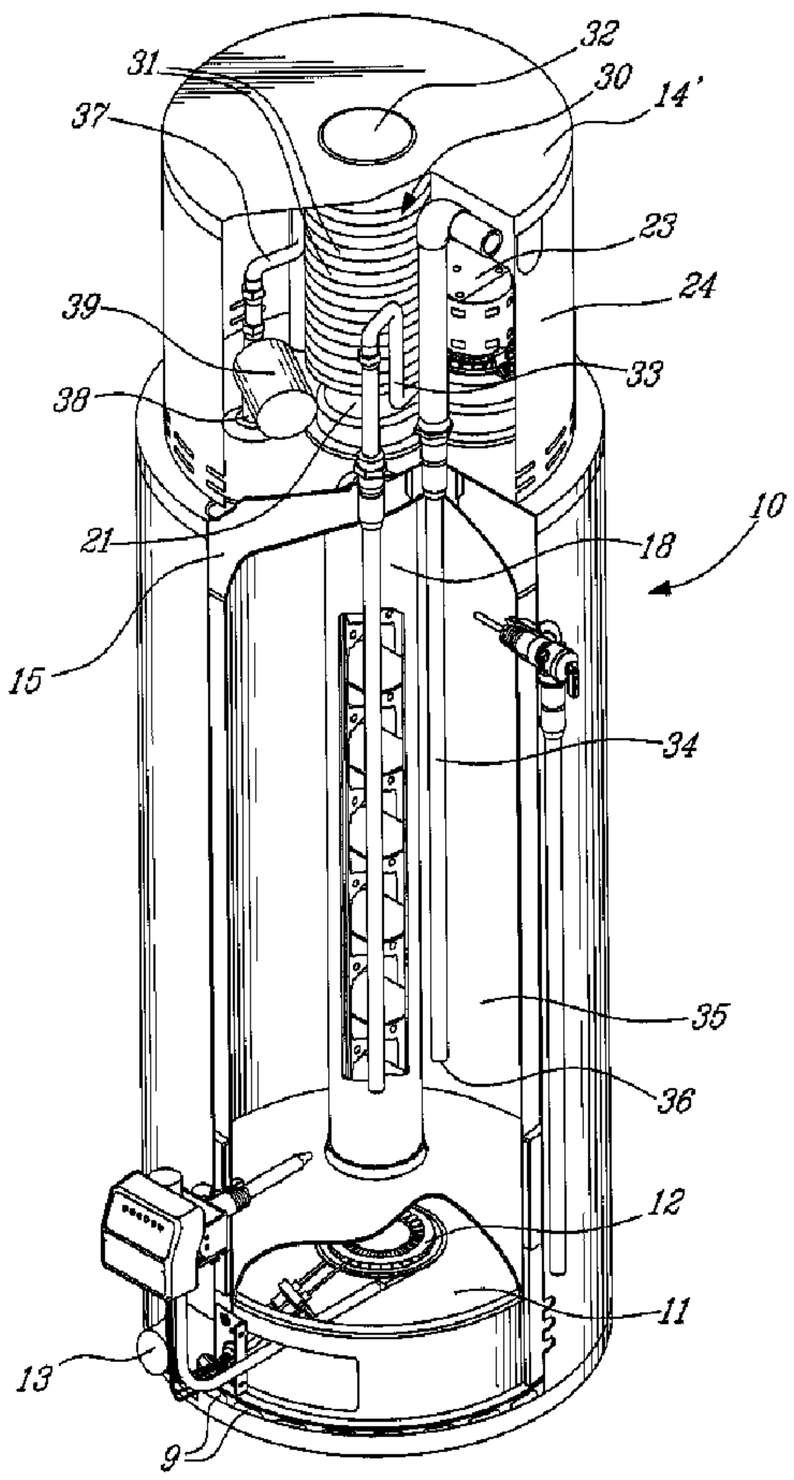
(54) Title: FUEL-FIRED WATER HEATER WITH AIR DRAFT INDUCER AND FLUE HEAT EXCHANGER



(57) Abrégé/Abstract:
A fuel-fired water heater has a tank which holds a reserve of water to be heated by a burner located in a sealed combustion chamber disposed under a bottom heat transfer wall of the tank. A combustion gas exhaust flue extends vertically through the

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(57) Abrégé(suite)/Abstract(continued):
center of the tank in contact with the water therein. A restrictive baffle is secured inside the gas exhaust flue to retard hot gases rising in the flue from the combustion chamber whereby to increase heat transfer from the hot gases to the water in contact with the exhaust flue. A draft inducing blower is secured in a top end of the exhaust flue above the top wall of the tank. A heat exchanger is in communication with a heat exchange section of the flue above the top end of the exhaust flue to extract further heat from residual hot gases in the exhaust flue.

ABSTRACT

A fuel-fired water heater has a tank which holds a reserve of water to be heated by a burner located in a sealed combustion chamber disposed under a bottom heat transfer wall of the tank. A combustion gas exhaust flue extends vertically through the center of the tank in contact with the water therein. A restrictive baffle is secured inside the gas exhaust flue to retard hot gases rising in the flue from the combustion chamber whereby to increase heat transfer from the hot gases to the water in contact with the exhaust flue. A draft inducing blower is secured in a top end of the exhaust flue above the top wall of the tank. A heat exchanger is in communication with a heat exchange section of the flue above the top end of the exhaust flue to extract further heat from residual hot gases in the exhaust flue.

FUEL-FIRED WATER HEATER WITH AIR DRAFT INDUCER AND FLUE HEAT EXCHANGER

TECHNICAL FIELD

The present invention relates to a fuel-fired water heater and more particularly, but not exclusively, a gas fired water heater provided with a central flue extending through the tank of the water heater and wherein a baffle is disposed inside the flue to retard the exhausting hot gases drawn up by a draft inducing blower and wherein the efficiency of the heat exchange is enhanced by a heat exchanger in a top end section of the flue to further extract heat exhausting from the top of the tank.

BACKGROUND ART

It is well known in the art to provide baffles in the exhaust flue of hot water heaters, such as domestic hot water heaters, whereby to retard the hot flue gases escaping from the bottom combustion chamber through the flue to obtain better heat exchange with the water being heated in the tank. It is also known to raise the pressure in the combustion chamber to increase efficiency of water heaters by using a more restrictive baffle. Reference is made to U.S. Patent 7,513,221 as an example of these. It is also known to install a draft inducer blower at the top end of the exhaust flue to increase the efficiency of the furnace and one such blower is described in U.S. Patent 7,278,823. These blowers pull flue gases through the baffle of the flue and then push the flue gases out through exhaust piping to the exterior of the building. However, there is a need to increase further this efficiency of such water heaters by extracting still more heat from the flue gases leaving the hot water heater.

SUMMARY OF INVENTION

It is a feature of the present invention to provide a fuel-fired water heater having improved heat exchange between the flue gases to heat the water in the tank of the water heater.

Another feature of the present invention is to provide a fuel-fired water heater having a central flue and wherein the heat exchange between the flue and the water in the tank is increased by using a restrictive baffle in combination with a draft inducer and wherein residual heat in the exhaust flue is further recovered, in part, by a heat exchanger in communication with the exhaust flue above the draft inducer.

According to the above features, from a broad aspect, the present invention provides a fuel-fired water heater which comprises a tank for holding a reserve of water to be heated by a burner located in a sealed combustion chamber disposed under a bottom heat transfer wall of the tank. A combustion gas exhaust flue extends vertically through the tank in contact with water therein. The exhaust flue has a bottom open end in communication with the sealed combustion chamber through the bottom heat transfer wall. The exhaust flue extends through a top wall of the tank. A restrictive baffle is secured inside the gas exhaust flue to retard hot gases rising in the gas exhaust flue to increase heat transfer from the hot gases to the water in contact with the exhaust flue. A draft inducing blower is in communication with a top end of the exhaust flue above the top wall of the tank to allow for increased efficiency of the baffle for the transfer of heat from the hot gases. A heat exchanger is in communication with a heat exchange section of the exhaust flue above the top end of the exhaust flue to extract further heat from residual hot gases in the exhaust flue.

BRIEF DESCRIPTION OF DRAWINGS

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a perspective fragmented view showing a gas fired water heater to which is secured at the top end of the gas exhaust flue a draft inducer blower;

FIG. 2 is a perspective view similar to Figure 1 and showing an additional heat exchanger coil in communication with the exhaust flue above the draft inducer;

FIG. 3 is a perspective view similar to Figure 2 and wherein the heat exchanger is located inside the gas exhaust flue above the draft inducer whereby to further extract heat from the combustion gases exiting the water heater;

FIG. 4 is a fragmented perspective view showing a further embodiment of the heat exchanger secured to the top end of the water heater about an open end of the gas exhaust flue; and

FIG. 5 is a fragmented side section view of the heat exchanger device illustrated in Figure 4.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings and more particularly to Figure 1, there is shown generally at 10 a gas-fired hot water heater of the domestic type. The hot water heater

10 is provided with a hot water glass-lined inner tank 15 provided, at a lower end thereof, with a sealed combustion chamber 11 in which there is mounted a fuel-fired burner 12. The burner may be an oil or gas burner. A vapor sensor 13 is secured close to the bottom end of the outer casing 14 of the hot water heater in close proximity to an inlet port 9. The outer casing 14 is spaced outwardly of the inner tank 15 and an insulation, not shown, surrounds the inner tank in the space 16 between the inner tank outer wall and the outer casing. This is a conventional domestic hot water heater design. Tank 15 may also be a stainless steel inner tank or other suitable tank to heat water therein.

Water to be heated is admitted in the inner tank 15 close to the bottom wall 17 of the inner tank and the hot water, which is hottest in the top end section of the tank, is retracted therefrom by an outlet pipe, not shown. As hereinshown, a central combustion gas exhaust flue 18 extends vertically through the inner tank 15 and is in contact with the water to be heated in the tank. The exhaust flue 18 has a bottom open end 19 which extends through the bottom wall 17 and in communication with the sealed combustion chamber and is disposed above the burner 12. A restrictive baffle 20 is secured in the gas exhaust flue 18 whereby to retard the hot flue gases rising through the restrictive baffle.

A draft inducer 21 is secured at the top end 22 of the gas exhaust flue 18 and includes a blower 23 whereby to impart a suction or negative pressure in the flue. The draft inducer permits a more restrictive baffle design to be used, such as illustrated herein, than a standard one, thus increasing the heat transfer from the hot gases to the water contained in the tank through the wall 18' of the gas exhaust flue 18.

The draft inducer 21 may also include a damper 24 that will close the draft inducer when the burner is not in operation thus stopping the hot air exhausting through the chimney by natural draft effect, therefore minimizing standby losses and increasing overall efficiency. It is pointed out that because the product of combustion exhausting through the chimney have been cooled down, a standard chimney, such as plastic pipes, may be used to vent the water heater gas.

The draft inducer 21 may also include one or more pressure switches to ensure that the combustion chamber is properly sealed and that an appropriate draft is established and maintained. The draft inducer can also work on different voltages such as 12, 24 are 120 volts. As hereinshown the draft inducer has a low profile design to fit the height of a standard draft hood 24, as shown in Figure 2. It is also pointed out that

the present design saves energy by not using house heated air for gas dilution, like any normal power vent.

In order to increase the efficiency of the hot water heater as shown in Figure 1, there is further provided, as shown in Figures 2 and 3, a further heat exchanger in communication with a heat exchange section of the exhaust flue 18 above the top end of the draft inducer 21 to extract further heat from residual hot gases in the exhaust flue.

As shown in Figure 2, the heat exchanger 30 is a heat extracting conduit coil 31 in contact about the heat exchange section 32 of the exhaust flue above the draft inducer 21. The heat extracting conduct coil 31 has an inlet end 33 in communication with a feed tube 34 which extends in the inner tank 15 to the lower end 35 of the tank to extract cold water therefrom. As previously mentioned, cold water from the domestic water supply is introduced in the lower end 35 of the inner tank by a feed tube 34 and enter the tank at its lower end 36. Accordingly, the water in the tank is cooler at the bottom than at the top where hot water propagates. The heat extracting conduct coil 31 has an outlet end 37 which is in communication with a return conduit 38 to discharge heated water from the heat extracting conduit coil 31 in an upper section of the inner tank 15.

A pump 39 is connected to the outlet end 37 to circulate cold water from the open end 36 of the feed tube 34, through the conduit coil 31 and back into the tank through the return conduit 38. Of course, the pump 39 may also be connected to the inlet end of the conduit coil to serve the same purpose. The coil 31 may have flat walls communicating with the flue and the coil windings for better contact with the flue and windings for improved heat transfer. With this additional heat exchanger 30 the efficiency of heat transfer between the flue gas and the water in the tank is increased to at least 93%.

Another embodiment of the heat exchanger 40 is illustrated in Figure 3. As hereinshown the heat exchanger is a heat extracting coil assembly disposed inside a heat exchange section 41 of the exhaust flue secured above the draft inducer 21. The heat extracting coil assembly 40 has a conduit coil 42 provided with an inlet end 43 in communication with the feed tube 44 which extends to the lower end 35 of the inner casing 15 to extract cooler water therefrom. The heat extracting coil 42 has an outlet end 45 which is in communication with a return conduit 46 to discharge heated water from the heat extracting conduit coil 42 in an upper section of the inner tank 15. The pump 47, secured to the outlet conduct 45, circulates the cold water from the bottom of

the inner tank through the heat exchanger 40 and back into the top end of the inner tank. As hereinshown, the heat extracting coil 42 is secured in a heat transfer module comprised of a series of spaced-apart heat sink fins 48. The fins extract heat from the residual hot gases in the exhaust flue as the gases flow through the fins and transfer heat to the heat extracting coil 42. The heat transfer module provides a baffle in the flue above the draft inducer and this further improves heat extraction from the flue gases.

It is pointed out that the restrictive baffle 20 provides a combustion efficiency of at least 80% and in combination with the heat exchanger 30 or 40 this efficiency is increased to about 93%. Thus, there is provided a higher efficient water heater.

Referring now to Figures 4 and 5, there will be described a still further embodiment of the heat exchanger, herein heat exchanger 50 constructed in accordance with the present invention. As hereinshown the heat exchanger 50 is comprised of a housing 51 having a heat exchange coil 52 supported therein. The housing 51 is a thermal insulated housing having a thermally insulated circumferential side wall 53 and a top wall 54. A central exhaust port 55 is provided in the top wall 54. The housing further has a bottom wall 56 also provided with a through bore 57 through which an open top end section 58 of the flue 18 exits.

Support means, herein in the form of support brackets 75, are under the bottom wall 56 and sit on the top wall 14' of the outer casing 14. A thermally insulating sleeve 59 is disposed in frictional contact with the top end section 58 of the flue 18 above the top wall 14' of the casing 14.

As hereinshown, the heat exchange coil 52 is comprised of two or more, herein four, spaced-apart concentric conduit windings 60. The inner conduit winding 60' has an inlet end connected to a water supply conduit 61 in communication with the lower end 35 of the inner tank 15. The outer conduit winding 60" is provided with an outlet end which is secured to a return conduit 62 secured to an upper section of the tank to discharge heated water from the heat exchanger coil 52 therein. A pump 63 is secured to the water supply conduit 61 to circulate water from the lower end 35 of the tank, through the heat exchanger coils 52 and back into the upper portion of the tank.

As better shown in Figure 5, the open end 58' of the open top end section 58 of the exhaust flue is disposed in a central through bore 64 formed inside the inner conduit winding 60'. A deflector member 65 is supported in the central through bore 64

spaced above the top end 58' of the flue. The deflector member 65 is an inverted casing having a cylindrical side wall 66 and a top wall 67. The deflector member has an open bottom end which is of larger diameter than the diameter of the open top end section 58 of the flue 18 whereby to define an annular passage 68 between the open top end section 58 of the flue, i.e., the cylindrical side wall thereof, for the convection of hot gases drawn into the deflector member 65 by the draft inducing blowers 25 which is now secured about the exhaust port 55. A vent pipe 69 is secured to the draft inducer to exhaust the hot gases exiting the exhaust port to atmosphere.

As better shown in Figure 5, the top wall 67 of the deflector member is a thermally insulated top wall and it has a concave inner face 67' to facilitate the reverse flow, as shown by arrows 70, of the hot gases exiting the open end 58' of the exhaust flue. The cylindrical side wall 66 of the deflector member is constructed of metal to provide good heat conductivity. The side wall 66 is also disposed in frictional contact with the inner conduit winding 60' of the heat exchange coil 52 to provide heat transfer thereto. The inner conduit winding 60' may have its conduit flattened on the side contacting the side wall 66.

As illustrated in Figure 5, the hot gases that are deflected downwardly, as shown by arrow 70, are directed to the lower end 71 of the housing 51 and are drawn upwardly through the concentric conduit windings of the coil 60 by the draft inducing exhaust blower 25 whereby water pumped through the coil 52 is heated while at the same time cooling the hot exhaust gases exiting the open end 58' of the flue. As previously pointed out, because of the high efficiency extraction of heat from the hot gases by the use of the combination of the high efficiency restrictive baffle 20 in the flue 18 and the heat exchangers 30, 40 or 50, it is possible to use vent pipes formed of plastics material whereby to exhaust the flue gases into atmosphere at the exterior of a building structure.

It is within the ambit present of the invention to cover any obvious modifications of the preferred embodiment described herein provided such modifications follow within the scope of the appended claims. It is also pointed out that the heated water from the heat exchangers 30, 40 and 50 may be feed to a further heat exchanger to heat air prior to returning the water to the tank.

We claim,

1. A fuel-fired water heater comprising a tank for holding a reserve of water to be heated by a burner located in a sealed combustion chamber disposed under a bottom heat transfer wall of said tank, air supply means to supply air for said burner, a combustion gas exhaust flue extending vertically through said tank in contact with water therein, said exhaust flue having a bottom open end thereof in communication with said sealed combustion chamber through said bottom heat transfer wall, said exhaust flue extending through a top wall of said tank, a high-efficiency restrictive baffle secured inside said gas exhaust flue to retard hot gases rising in said gas exhaust flue to increase heat transfer from said hot gases to said water in contact with said exhaust flue, a draft inducing blower in communication with a top end of said exhaust flue above said top wall of said tank to allow for increased efficiency of said restrictive baffle for the transfer of heat from said hot gases, and a heat exchanger in communication with a heat exchange section of said exhaust flue above said top wall of said tank to extract further heat from residual hot gases in said exhaust flue.

2. A fuel-fired water heater as claimed in claim 1 wherein said heat exchanger is a heat extracting conduit coil in contact about said heat exchange section of said exhaust flue, said heat extracting conduit coil having an inlet end in communication with a feed tube extending to a lower end of said tank to extract cool water therefrom, said heat extracting conduit coil having an outlet end in communication with a return conduit to discharge heated water from said heat extracting conduit coil in an upper section of said tank, and a pump secured to one of said inlet or outlet end of said heat extracting conduit coil to circulate water therethrough.

3. A fuel-fired water heater as claimed in claim 1 wherein said heat exchanger is a heat extracting coil assembly disposed inside said heat exchange section of said exhaust flue, said heat extracting coil assembly having a conduit coil having an inlet end in communication with a feed tube extending to a lower end of said tank to extract cool water therefrom, said heat extracting coil having an outlet end in communication with a return conduit to discharge water from said heat extracting conduit coil in an upper section of said tank, and a pump secured to one of said inlet or outlet end of said heat extracting conduit coil to circulate water therethrough.

4. A fuel-fired water heater as claimed in claim 3 wherein said heat extracting coil is secured in a heat transfer module comprised of a series of spaced-apart heat sink fins for extracting heat from said residual hot gases in said exhaust flue and transferring heat to said heat extracting coil, said heat transfer module providing a baffle for exhausting flue gases.

5. A fuel-fired water heater as claimed in claim 1 wherein said heat exchanger comprises a housing having a heat exchanger coil supported therein, support means to insulatingly support said housing about an open top end of said exhaust flue above said top wall of said tank, said open top end of said exhaust flue being disposed in a central through hole formed by said heat exchanger coil, a deflector member supported in an upper portion of said central through bore spaced about said open top end and extending inside an inner surface of said heat exchanger coil, said housing having an exhaust port in a top wall thereof spaced above said central through bore, said draft inducing blower being secured about said exhaust port, said heat exchanger coil being supported in said housing spaced above a bottom wall of said housing whereby said hot gases rising in said gas exhaust flue are deflected downwardly by said deflector member to be connected towards a lower end of said heat exchanger coil to heat water pumped through said heat exchanger coil, said hot gases being cooled by said heat exchanger coil and exhausted through said exhaust port.

6. A fuel-fired water heater as claimed in claim 5 wherein said heat exchanger coil is comprised of two or more spaced-apart concentric conduit windings, said conduit windings having an inlet end and an outlet end, said inlet end being connected to a water supply conduit in communication with a lower end of said tank to extract cold water therefrom, said outlet end being secured to a return conduit secured to an upper section of said tank to discharge heated water from said heat exchanger coil therein, and a pump secured to one of said inlet or outlet end to circulate water through said heat exchanger coil.

7. A fuel-fired water heater as claimed in claim 6 wherein a vent pipe is secured to said draft inducer to exhaust said hot gases exiting said exhaust port to atmosphere.

8. A fuel-fired water heater as claimed in claim 6 wherein said housing is a thermally insulated housing.

9. A fuel-fired water heater as claimed in claim 5 wherein said deflector member is an inverted casing having a cylindrical side wall, a top wall and an open bottom end; said open bottom end being of larger diameter than the diameter of said exhaust flue to define an annular passage between said cylindrical side wall and said exhaust flue for the connection of said hot gases.

10. A fuel-fired water heater as claimed in claim 9 wherein said top wall of said inverted casing is a thermally insulated top wall.

11. A fuel-fired water heater as claimed in claim 10 wherein said top wall has a concave curvature in an inner face thereof to facilitate a reverse flow of said hot gases exiting said open top end of said exhaust flue.

12. A fuel-fired water heater as claimed in claim 9 wherein said cylindrical side wall is a heat conducting side wall disposed in frictional contact with an inner one of said concentric conduit windings, said inner one of said concentric conduit windings having a coil section thereof flattened for contact with their heat conducting side wall.

13. A fuel-fired water heater as claimed in claim 1 wherein said petroleum-fired water heater is a gas-fired domestic water heater.

14. A fuel-fired water heater as claimed in claim 13 wherein said tank is one of an inner glass-lined tank or stainless steel tank or other suitable tank, an outer casing spaced from said inner tank and an insulation disposed between said inner tank and said outer casing.

15. A fuel-fired water heater as claimed in claim 1 wherein there is further provided a damper in said top end of said exhaust flue to substantially close said exhaust flue when said draft inducer is inoperative.

16. A fuel-fired water heater as claimed in claim 1 wherein there is further provided a flammable vapor sensor secured to a bottom end of said water heater to prevent said burner to be ignited in the presence of flammable vapors.

17. A fuel-fired water heater as claimed in claim 1 wherein said restrictive baffle provides a thermal efficiency of at least 80%.

18. A fuel-fired water heater as claimed in claim 17 wherein said restrictive baffle in combustion with said heat exchanger increases the efficiency to about 93%.

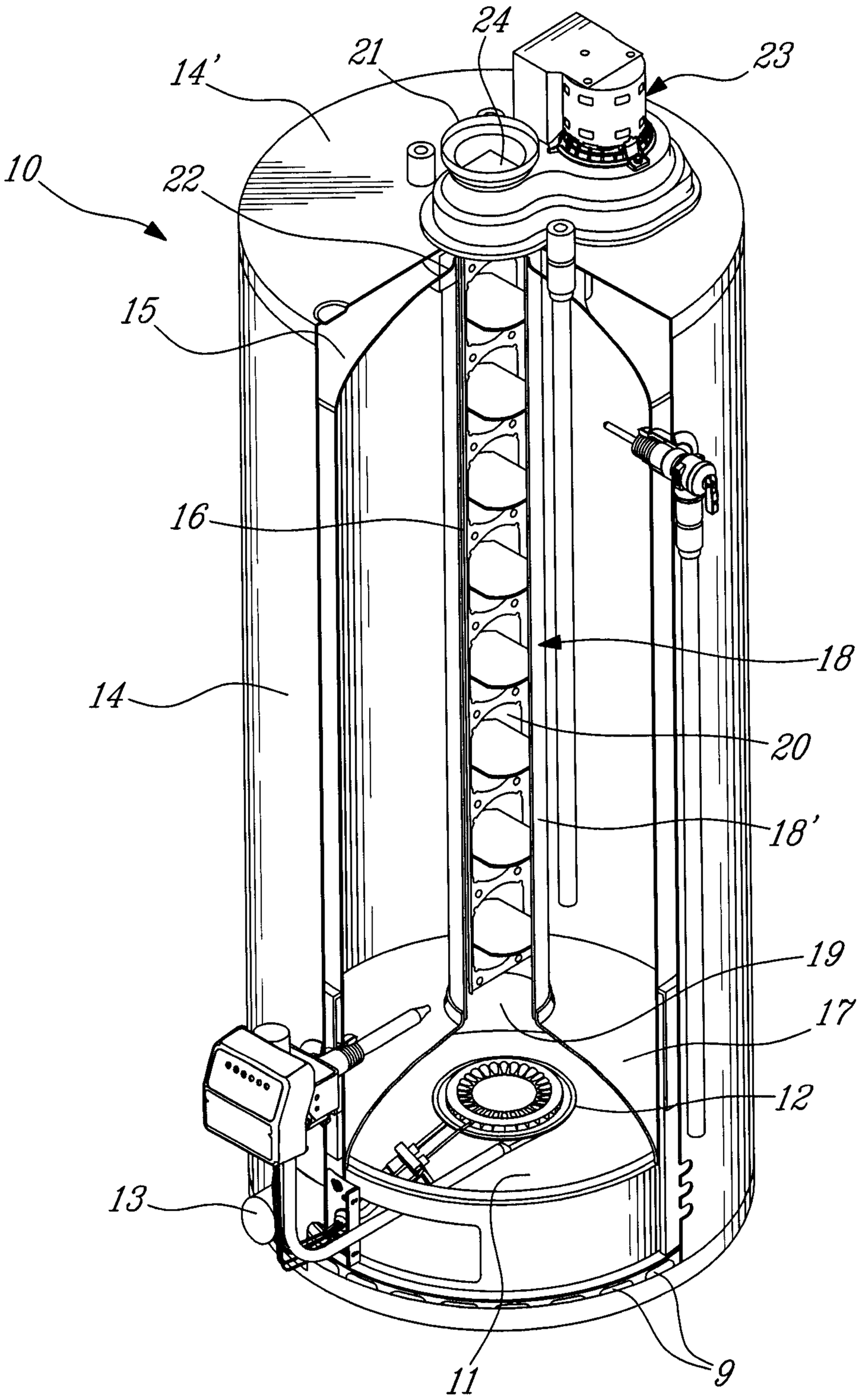

Fig-1

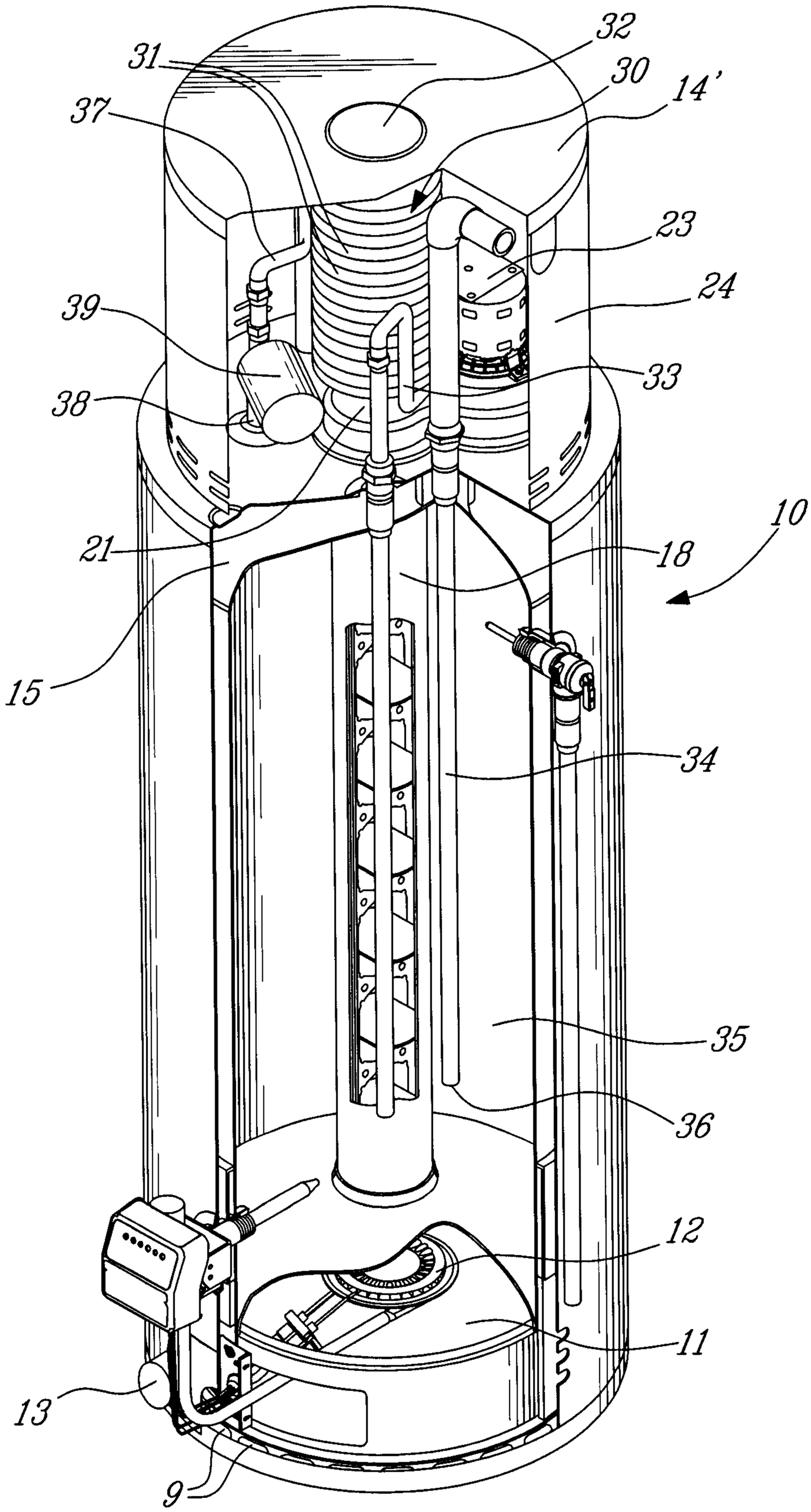

Fig-2

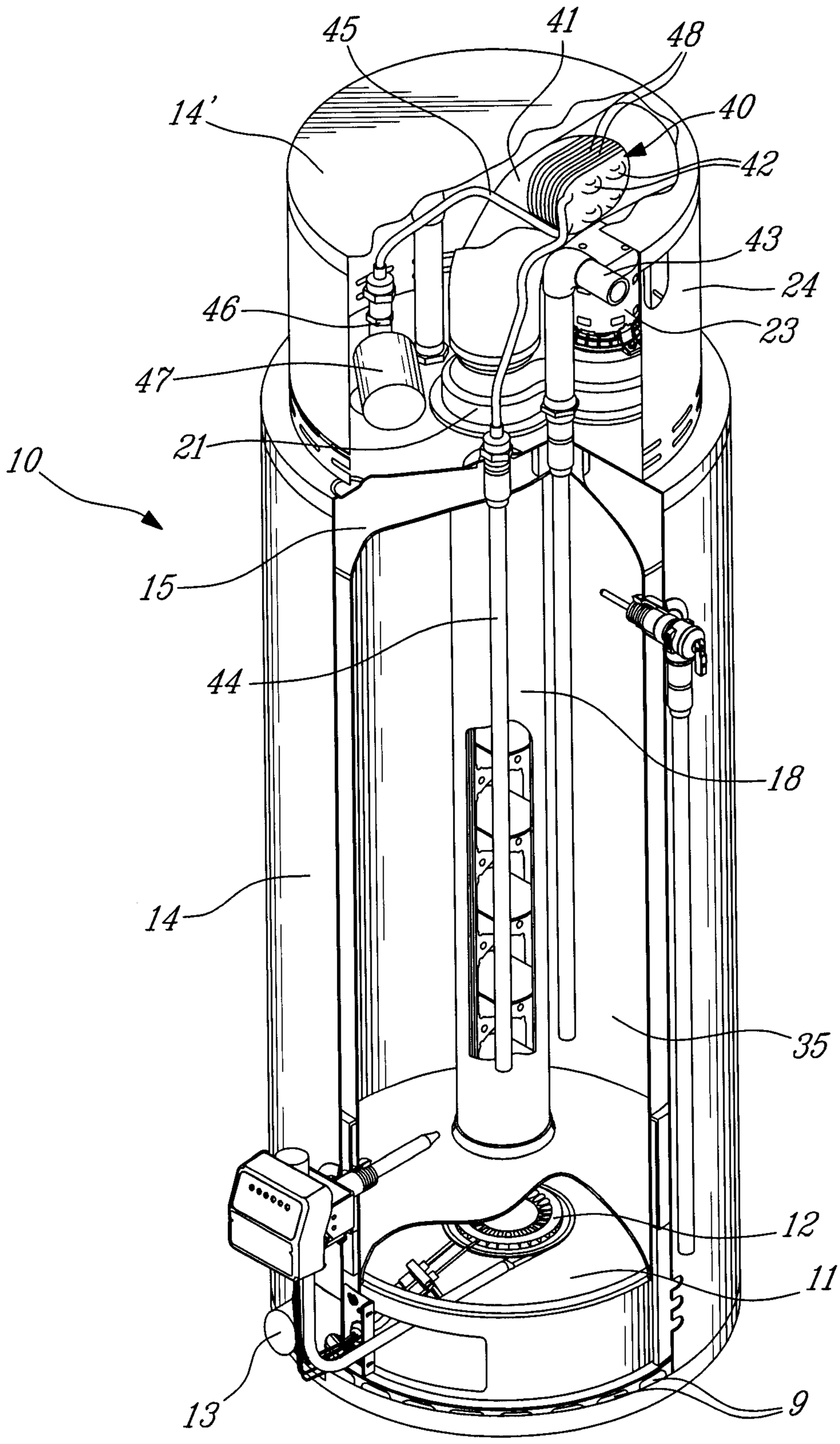

Fig. 3

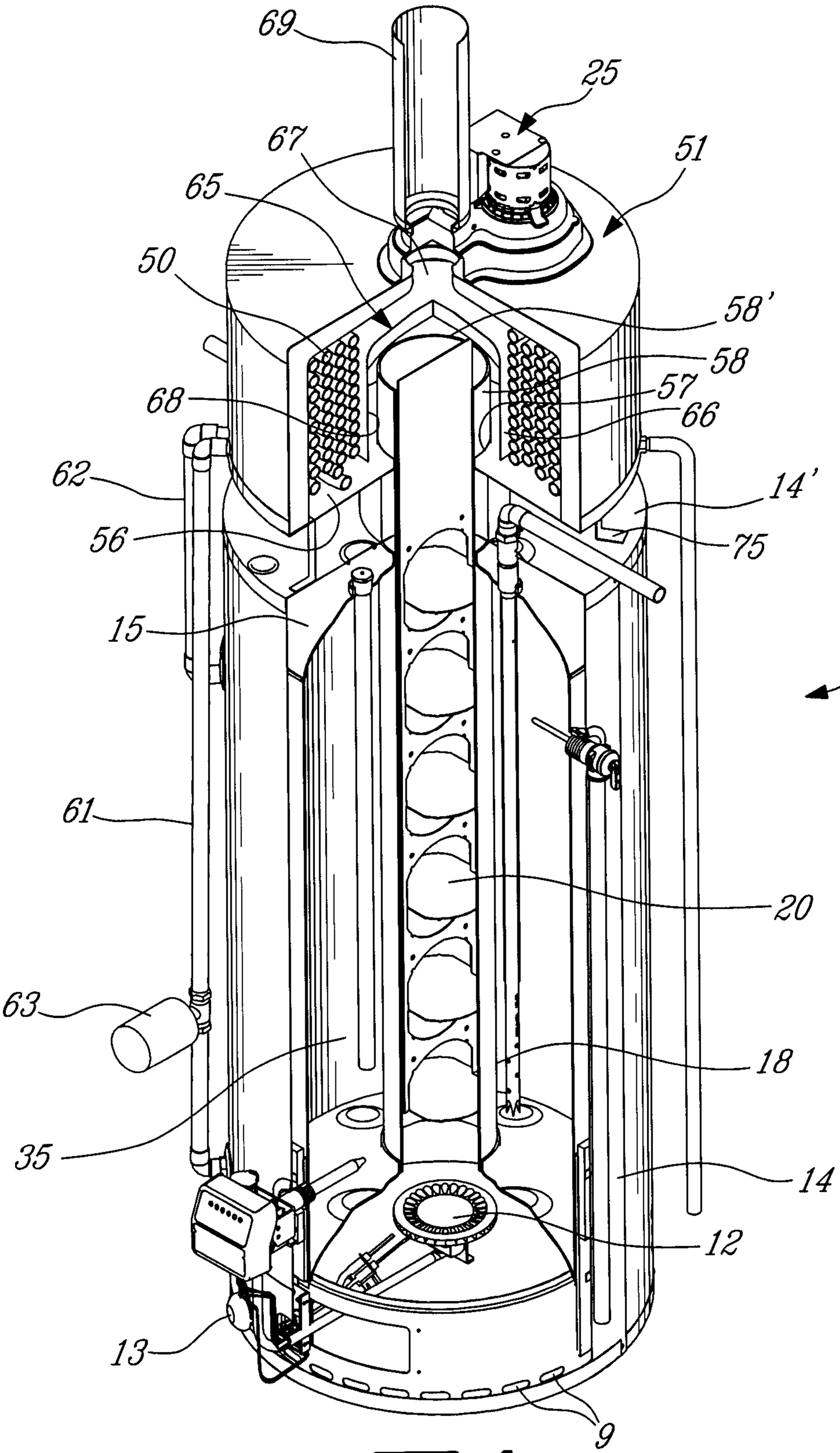
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Fig-4

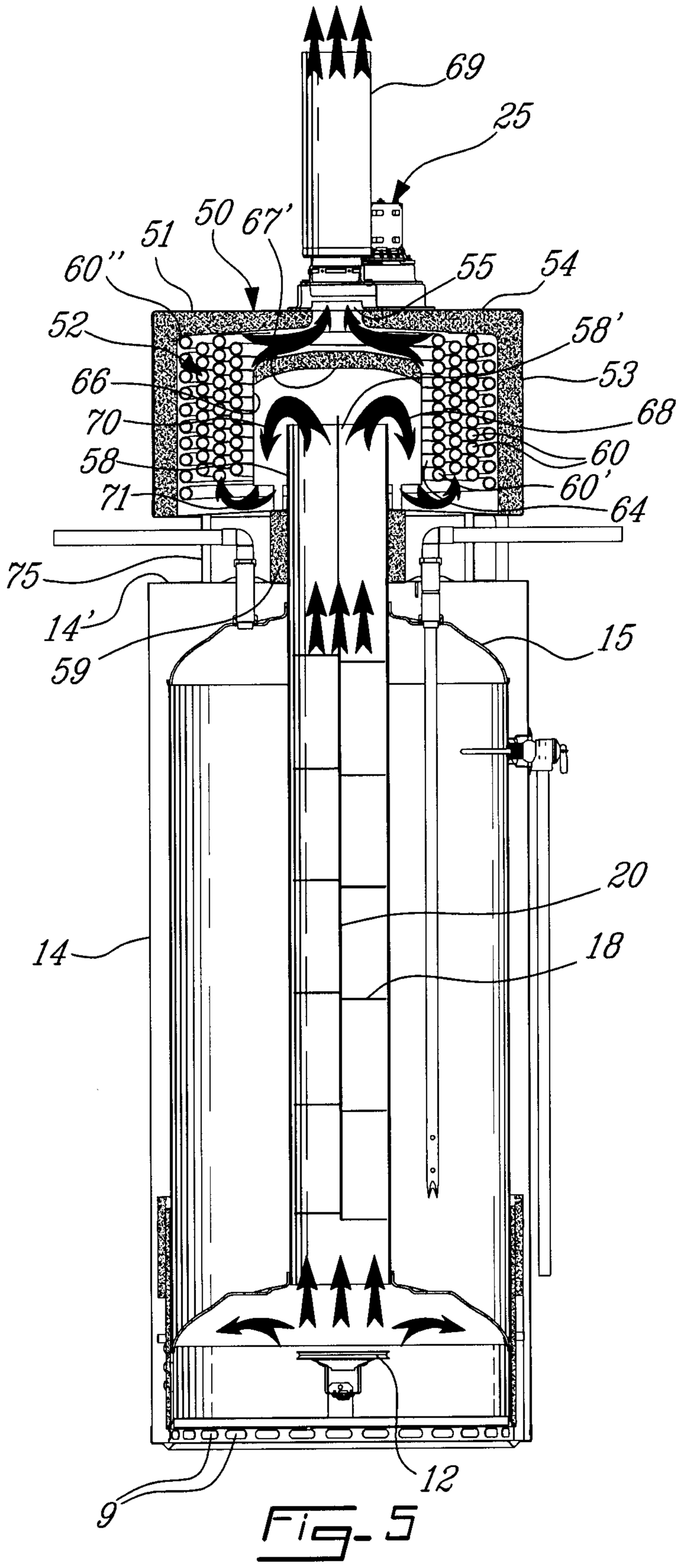
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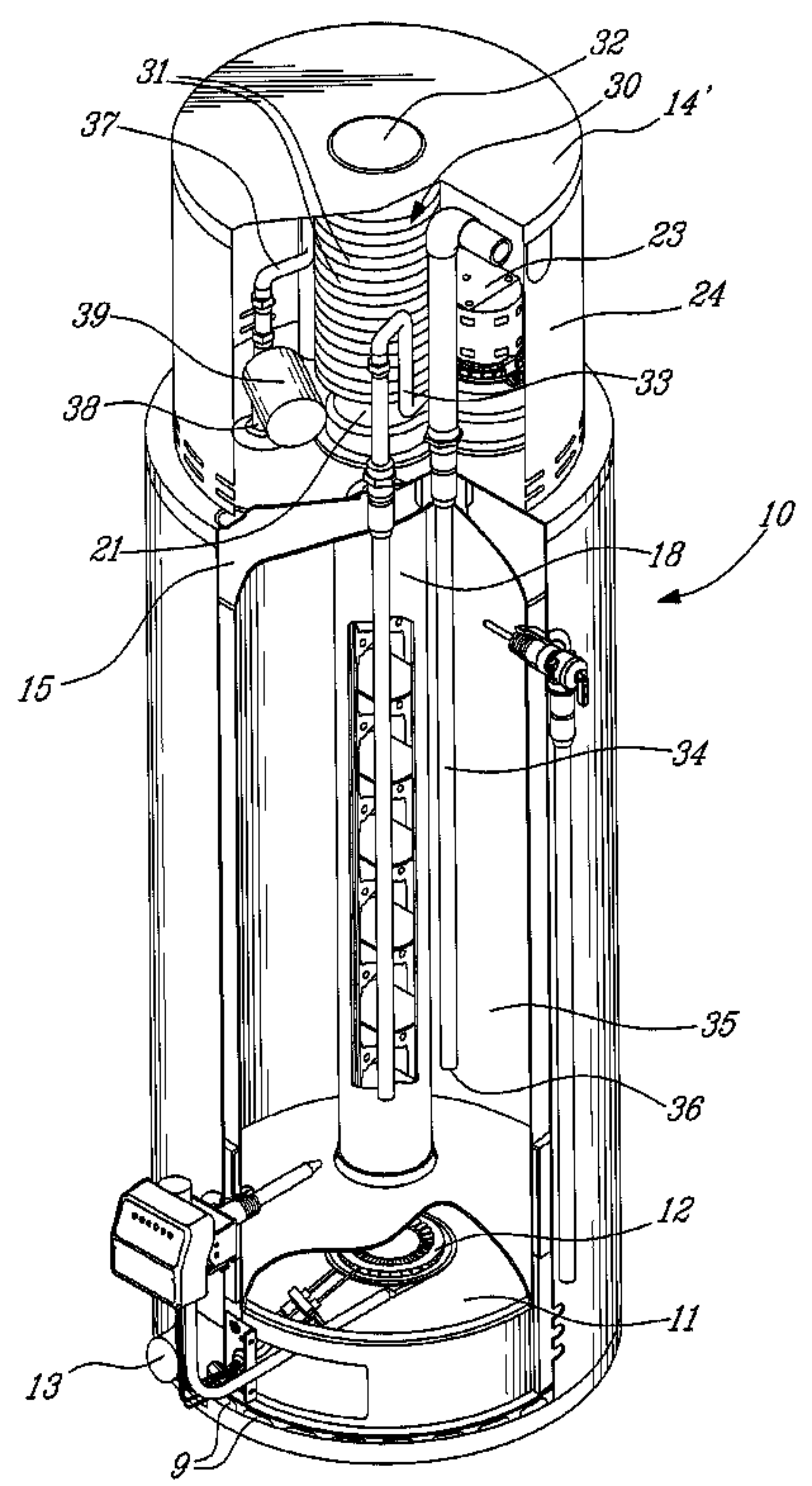
Fig. 5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